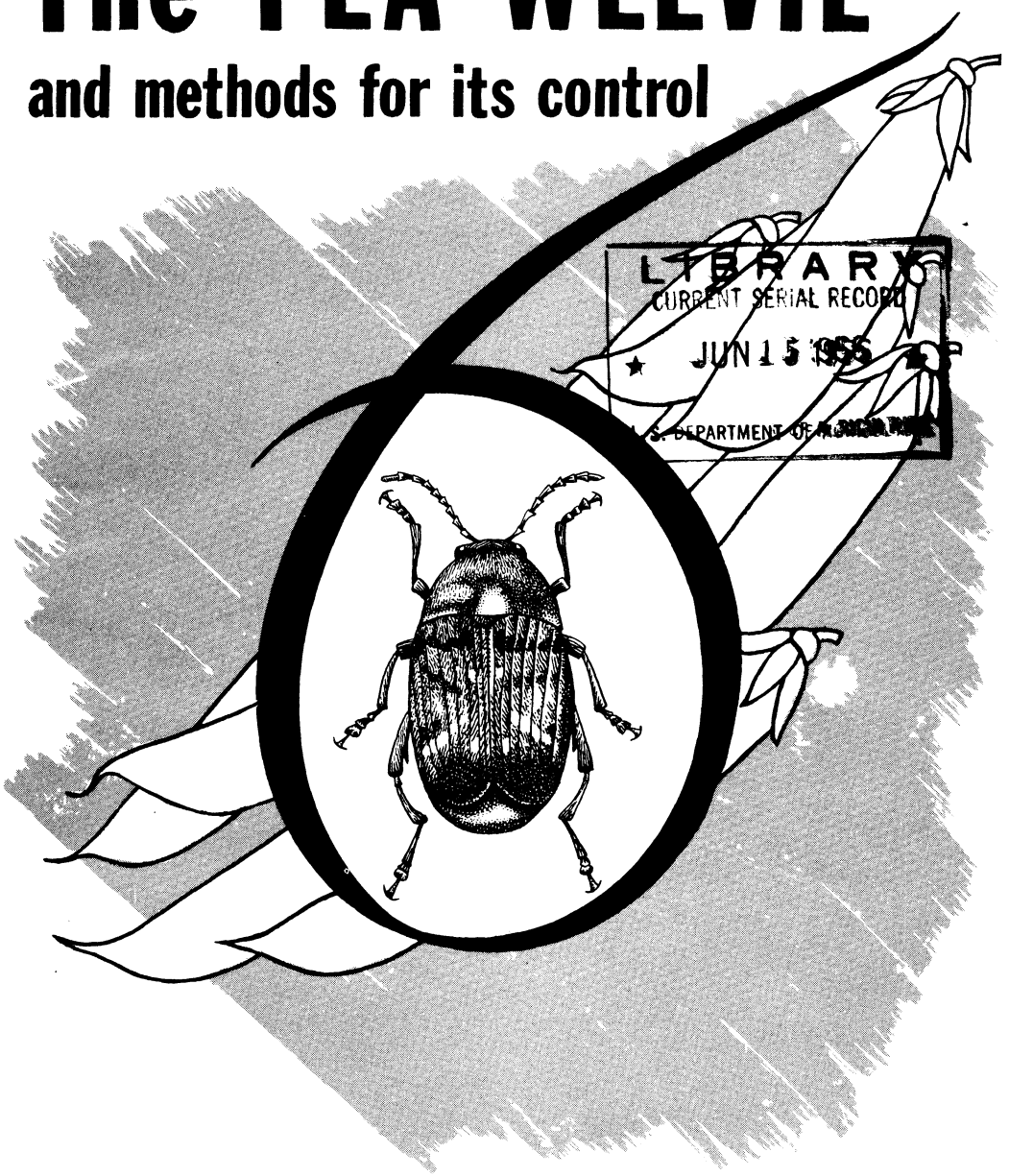
The PEA WEEVIL

and methods for its control



FARMERS' BULLETIN
No. 1971

U. S. DEPARTMENT OF AGRICULTURE

THE PEA WEEVIL may damage your peas if they are grown where large acreages of this crop mature as dry peas or seed.

To prevent damage you must recognize the pea weevil and know its habits.

Look upon the application of insecticides as a form of crop insurance. See that they are applied when they are needed, when they will be effective, and before the damage is done.

You will need an insect net to determine where to apply insecticides.

Use good equipment and keep it clean and in good working order at all times.

Insure your health against insecticides by taking proper precautions while handling or applying them.

This bulletin is prepared to help you. Read it carefully.

Washington, D. C.

Revised April 1952
Slightly revised January 1956

THE PEA WEEVIL AND METHODS FOR ITS CONTROL [1]

By T. A. BRINDLEY,[2] J. C. CHAMBERLIN, and RALPH SCHOPP, *entomologists, Division of Truck Crop and Garden Insect Investigations, Bureau of Entomology and Plant Quarantine, Agricultural Research Administration*

Contents

THE PEA WEEVIL [3] is one of the most injurious insect pests of cultivated peas in the United States. It does not affect other leguminous crops, but it attacks all varieties of edible and field peas, whether grown for processing or for seed. It is nearly world-wide in distribution and has been recorded as doing serious damage wherever peas are grown on an extensive scale. Countries from which serious injury has been reported in recent years include Canada, the United States, South Africa, Russia, Japan, and Australia.

The pea weevil was once believed to be a native of North America, since it was first recorded as damaging peas in the United States. This was doubtless a mistake, because cultivated peas are not native to this country and the pea weevil has no other host plant. It was undoubtedly introduced into the United States, along with its host, at an early but unknown date.

Serious damage by the pea weevil was apparently first noted in Pennsylvania, New Jersey, and New York as early as 1748. It has since been reported as present in practically every other State in the Union. In recent years it has been of special importance in the northwestern part of the United States, particularly in the larger pea-growing areas of Utah, Idaho, Washington, Oregon, and California.

---

[1] The research work upon which this bulletin is based was conducted in cooperation with the Idaho, Oregon, and Washington Agricultural Experiment Stations. F. G. Hinman, Bureau of Entomology and Plant Quarantine, and K. W. Gray, formerly with the Oregon Agricultural Experiment Station, participated in the early phases of this work.

[2] Now employed by the Division of Cereal and Forage Insect Investigations, Bureau of Entomology and Plant Quarantine, and the Iowa Agricultural Experiment Station.

[3] *Bruchus pisorum* (L.), order Coleoptera, family Bruchidae.

In certain areas, particularly those marked by long and severe winters, such as the upper Snake River Valley of eastern Idaho and parts of Montana, or in areas characterized by exceptionally heavy and long-continued winter rains, as in the coastal area of northwestern Oregon, the pea weevil is generally rare or absent and of no economic importance. In general, any new area suitable for commercial production of peas can be evaluated as to potential damage from the pea weevil on the basis of infestations in home plantings or in small truck gardens in the area. If these plantings are usually injured by the weevil, it can be regarded as certain that large commercial acreages would ultimately be similarly affected, probably within 2 or 3 years at best.

Thus far the pea weevil has not established itself in the agricultural areas of Alaska, although several sections in the Territory are eminently suitable for producing edible peas of high quality.

CHARACTER OF INJURY

Pea weevils damage peas by the feeding of the larvae within the seeds. Generally but one larva develops in a single seed, but so many eggs may be laid that in extreme cases practically every pea may be infested. This is particularly true of certain areas in the Willamette Valley of Oregon, where infestations affecting from 70 to 90 percent of the crop have been observed and where they frequently average 30 to 70 percent, if control measures are not applied. In other sections, such as the Palouse area of eastern Washington and northern Idaho, the average is lower, although infestations ranging from 5 to 50 percent are not uncommon.

The injury done by a weevil larva is restricted to the seed, which it first enters shortly after hatching. In the course of its development the rapidly growing larva consumes a large part of the substance of the pea, thus destroying or greatly impairing the viability of the seed. The weevil-infested, or "wormy," peas are unfit for human consumption. In dry peas the feeding of the larvae not only destroys the viability of large numbers of the seeds, but also impairs their weight, food value, and palatability where they are grown and milled for stock feed.

PRINCIPAL SOURCES OF PEA WEEVIL INFESTATION

The principal sources of pea weevil infestation are (1) peas shattered in the field, (2) volunteer peas, (3) pea hay containing weevil-infested peas, and (4) weevil-infested seed in storage.

PEAS SHATTERED ON THE FIELD

Field shatter is the most important source of pea weevil infestation in seed-pea areas. From 7 to 50 percent of the peas in the fields are lost on the ground during harvest. From these peas the weevils emerge, seek hibernation quarters, overwinter until the following spring, and then attack the next year's crop (fig. 1).

FIGURE 1.—A typical bit of harvest loss due to shattering in a field of Alaska peas. In such shattered peas weevils survive to attack the next year's crop.

VOLUNTEER PEAS

Peas left on harvested fields often sprout during the winter and produce plants that bloom the following year in the winter wheat sown in those fields. These volunteer plants frequently become heavily infested with pea weevils and shatter out before the wheat is harvested. From the shattered peas the weevils emerge and are ready to infest the peafields the second spring.

PEA HAY

Peas grown for hay may liberate many pea weevils unless this hay is fed before such weevils can complete their development and escape. Hay cut while the pods are still nearly flat may contain seeds large enough to permit the pea weevil to complete its development. Such weevils are much smaller than those that feed on larger peas but are otherwise normal.

WEEVIL-INFESTED SEED

Seed containing living pea weevils is obviously a source of infestation because the weevil may escape from the place of storage. When the seed is planted before the weevils emerge, many of them survive and escape from the infested peas and the surrounding soil.

LIFE HISTORY AND HABITS

The adult pea weevil is a small, grayish or brownish-gray beetle about one-fifth of an inch long and marked with black and white spots (fig. 2).

The life cycle of the pea weevil is essentially a simple one, with a

single generation annually. The winter is passed in the adult stage. The weevils fly into the peafields at the end of the hibernation period, at a time which coincides rather closely with the blossoming period of the peas. The eggs are laid on living, green pods only. Unlike some of its relatives, such as the bean weevil (*Acanthoscelides obtectus* (Say)), the pea weevil is incapable of breeding continuously in the dried seed. Instead the larvae develop in the growing green

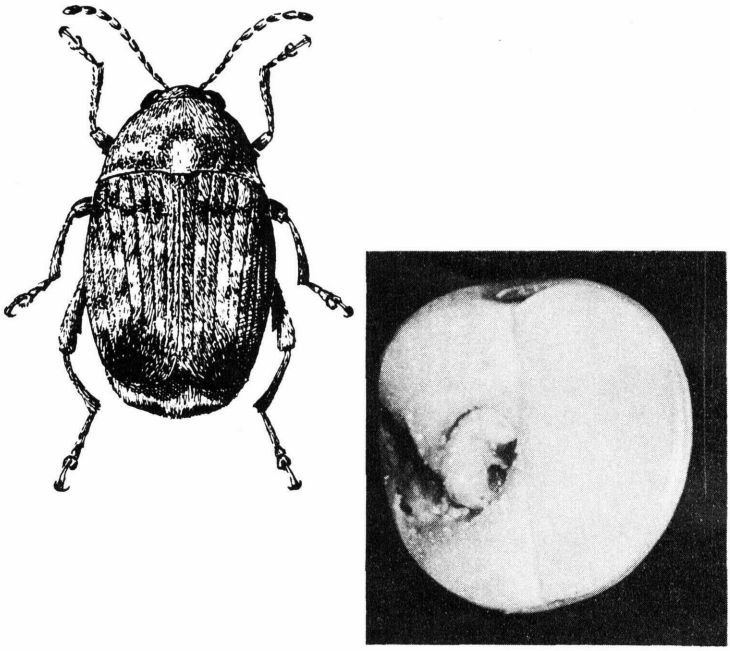


FIGURE 2.—The pea weevil, 8 times natural size, and its grub feeding in a green pea, 4½ times natural size.

peas, completing their larval development some time after the normal crop has matured. They emerge from the infested seeds late in the summer and in the fall, and seek a protected spot in which to pass the winter, preparatory to repeating the cycle the following year.

The female weevil lays her eggs either singly or in pairs, one above the other, on the outside of the pea pod, attaching them to the pod by means of a transparent gluelike substance. When first deposited the egg is orange, oval, slightly less than one-sixteenth of an inch long, and about half as broad. Six or seven days after the eggs are deposited, and about two days prior to hatching, a black spot appears at the end of each egg. This black spot is the head of the developing weevil grub, or larva. The time required for the egg to hatch depends on the temperature—it may hatch in 5 days in very warm weather, or may require several times as long in cool weather. In general, the average time required for hatching is about 8 or 9 days.

When the larva is ready to hatch, it bores through the thin shell

of the egg at the point of attachment, through the wall of the pea pod, and into one of the young peas within the pod cavity. Several larvae may enter one pea, but because of insufficient nourishment, only one is able to survive. A small, dark spot, or "sting," on the seed coat indicates the point of entrance. This "sting" can first be found in infested green peas (fig. 3). In some instances the newly hatched larva dies shortly after entering the pea, resulting in what is known as "pinhole" weevil infestation. The viability of the "stung" pea is not affected; nevertheless, in edible varieties such peas must be graded out and this constitutes a serious problem in certain areas and in certain seasons.

The newly hatched larva is white and about one-sixteenth of an inch long. It continues to feed within the growing pea and increases in size slowly, gradually consuming a large part of the interior of the pea, while the pea continues to grow. The larva attains its full

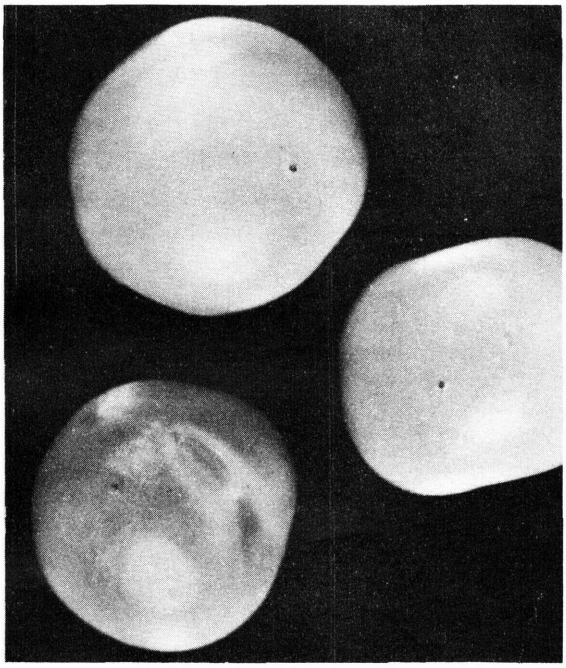


FIGURE 3.—Weevil-infested green peas. The small dark spots indicate places where the tiny larvae entered the peas.

growth at the end of 5 or 6 weeks. At this time its body usually fills a large part of the interior of the pea, which has developed to the ripened stage.

The full-grown larva is about one-fourth of an inch long and about half as wide. It is crescent-shaped, robust, slightly curled, and white or cream-colored. When the larva has reached its full size within the pea, it has eaten away the interior of the seed as far as the outer skin, leaving a thin circular cap, or "window," as a means of exit for the future adult.

Soon after it becomes full-grown the weevil larva transforms to the pupal, or resting, stage in the cavity formed by its feeding inside the pea. The pupa is about the same size as the adult weevil, and is cream-colored. Roughly oval in shape, the pupa shows on the delicate surface of its body the outlines of the legs, antennae, eyes, and mouth parts of the future adult. After 8 days to 2 or 3 weeks, depending on the temperature, the pupa transforms to an adult, thus completing the life cycle.

When the adult pea weevil is ready to emerge, it pushes out the circular "window" formed by the larva and crawls out of the pea (fig. 4). It may leave the pea soon after becoming an adult or, under certain storage conditions, it may stay all winter and emerge the following spring.

The entire developmental period of the pea weevil, from egg to adult, in the Northwestern States requires on an average about 2 months. In general, it is late in July or early in August before adults are developed and ready to emerge from peas seeded early in the spring.

Adult weevils emerge from ripe, unharvested, or shattered peas over a period of approximately 2 months, during the latter part of

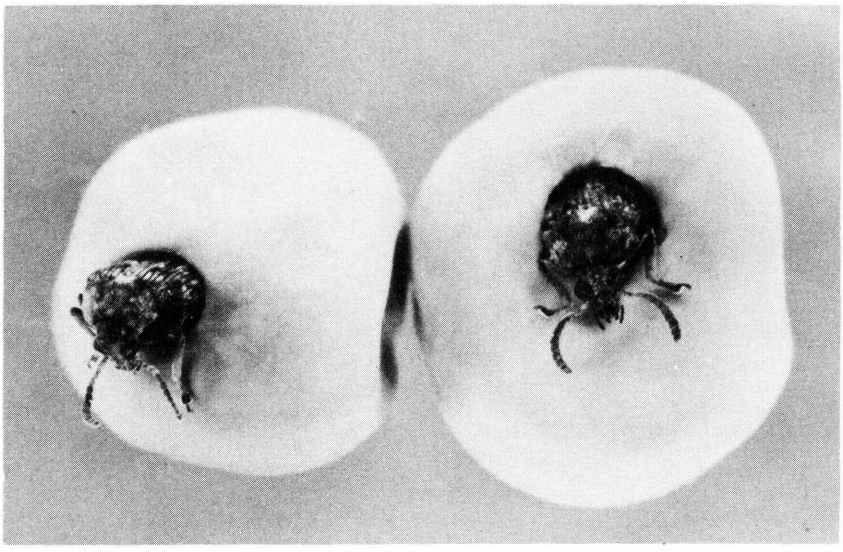


FIGURE 4.—The adult weevils leave the peas and seek hibernation quarters shortly after completing development, unless the peas are stored in a cool, dry place.

the summer and the early part of the fall in the Northwestern States. In harvested peas the weevil, unless killed by fumigation or other treatment, may remain in hibernation within the container of the seed throughout the winter, escaping when the seed is removed from storage for planting or processing. Sometimes the adult weevil remains within the seed itself during this period. The pea weevil requires neither food nor water during the hibernation period, and weevils have been kept alive without either for 18 to 24 months. In

general, however, very few of the weevils confined in peas in storage from which escape is impossible (for example, when stored in tight bags) will survive longer than midsummer or early fall of the year following the harvest. A very few have survived a second winter in storage, but none have survived a third winter.

Except for the individuals that pass the winter in stored, nonfumigated seed, the adult pea weevil overwinters in any location affording protection from the weather. Such protection is found commonly in and about barns, in crevices in fence posts, in straw left on harvested fields, under the bark of trees, and in similar places. In the Palouse area of Washington and Idaho the rough bark of the ponderosa pine and the duff or dead leaves beneath these trees afford excellent hibernation quarters.

Exposure to temperatures below 0° F. will kill many overwintering weevils and thus reduce the infestation for the following year. In many instances, however, the weevils are so well protected in their hiding places that many survive when the temperature of the air is as low as −16°. Where snow cover affords additional protection, many pea weevils survive even much lower temperatures.

The pea weevils start coming out of hibernation quarters about the time the earliest peas begin to bloom. Some weevils may be found in the fields before any blossoms have appeared, but most of them fly in during the blooming period. Emergence from hibernation and flights into the peafields continue for 2 months or more, principally during May and June, on days when weather is favorable. Peak influxes occur on pleasant days when the temperature ranges from about 68° to 80° F. Other things being equal, the higher the temperature the larger is the flight. Weevils may fly at least 3 miles between overwintering quarters and peafields.

The weevils usually alight first near the edge of the first blossoming peafield they encounter; consequently the most heavily infested fields are those nearest favorable overwintering places, and the edges of the field, especially the edge nearest a favorable hibernation place, are almost always much more heavily infested than the interior. For instance, in the Palouse area the fields nearest ponderosa pine forests, which afford very favorable hibernating quarters, are usually the most heavily infested. When the time of blooming is not uniform, however, the weevils may concentrate on the early blossoming vines, regardless of their location in the field. In such areas as the Willamette Valley of Oregon, where the fields are relatively small and often located in densely populated areas, the parts of fields nearest houses, barns, and other outbuildings are usually most heavily infested.

The adult weevil does not feed to an important extent on its host plant, apparently being sustained during this stage by its accumulated fat reserves, supplemented by a diet composed largely of nectar and pollen. All direct injury done by this insect is consequently caused by the feeding of the immature, or larval, stages, the adults being important only as the parents of a new generation. The female, however, must feed on pollen in order to develop her eggs, and usually feeds on the pollen of the pea blossom. It is generally 4 or more days from the time she flies to the blossoming peas (fig. 5, *A*) before she begins to lay eggs (fig. 5, *B*). A female may lay several hun-

dred eggs during the season, and as many as 50 in 1 day, provided weather conditions are favorable.

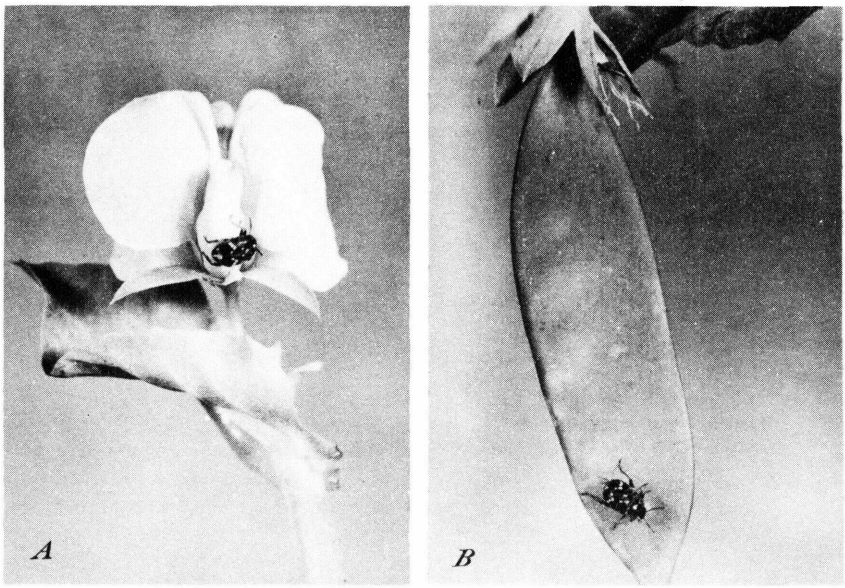


FIGURE 5.—*A*, After hibernation the weevils seek blossoming peas. They feed principally on the pollen of the pea flowers. *B*, As soon as the pods are formed, the females begin laying eggs on them.

NATURAL ENEMIES

Natural enemies, such as insect parasites or predators, do not seem to be important factors in holding pea weevil populations in check in the United States. In Europe parasites are present and in some places appear to be effective. From time to time attempts have been made to introduce certain of these parasitic species—*Triaspis thoracicus* (Curt.), in particular—into the pea weevil-infested areas of the United States, but thus far such attempts have failed. The role of predators, such as other insects and birds, has not been fully evaluated. Although many pea weevils are certainly destroyed by such enemies, there is no evidence that they are sufficiently effective to prevent pea weevil outbreaks.

CONTROL WITH INSECTICIDE DUSTS

EFFECTIVE INSECTICIDES

Field infestations of the pea weevil may be controlled with dusts containing 0.75 percent of rotenone or 5 percent of either DDT or methoxychlor during the early bloom period before the eggs are laid. The dusts may be purchased in the form to be applied, or they may be prepared by thoroughly mixing the dust concentrate with talc or

diatomaceous earth. Lime or other alkaline diluents should not be used with any of these materials.

Rotenone is the safest of the insecticides to use against the pea weevil because of its very low toxicity to warm-blooded animals. At the dosages recommended for insect control rotenone is relatively harmless to all plants and to man. It does irritate the mucous membrane of the nose and throat, however, and a person continuously exposed may find it desirable to wear a respirator. It deteriorates slowly upon exposure to light and moisture, and should therefore be stored in tightly closed containers that will not admit light.

DDT remains on the foliage longer than rotenone and kills the weevils that come in contact with it for several days after application. It is stable in storage, and relatively inexpensive. However, it has the disadvantage of remaining as a poisonous residue on the plants at harvesttime. If the treated plants are eaten by livestock, the DDT is deposited in the fat of the body and milk. Rotenone or methoxychlor should therefore be used instead of DDT if the pea ensilage or pea hay is to be fed to livestock.

Methoxychlor is fully as effective as DDT against the pea weevil and is relatively harmless to warm-blooded animals. Do not apply methoxychlor to peas with edible pods within 7 days before a harvest.

***Caution.*—In handling, mixing, or applying insecticides be careful to keep the materials out of the mouth and eyes. During dusting operations cover the body well and wear goggles to protect the eyes. Do not apply DDT to pea vines to be fed to livestock. Do not apply DDT to varieties with edible pods after the pods form. Mark insecticide containers plainly and keep them out of reach of children and others unfamiliar with their poisonous nature.**

CONTROL ON DIFFERENT TYPES OF PEA CROPS

From one to three applications at 15 to 30 pounds per acre will be required of any of these dusts. For some crops and under some conditions more and heavier applications may be necessary. The degree of control will depend upon whether the peas are to be harvested before or after they mature and whether or not they are edible. It is not practical to remove the weevil grubs from the immature peas harvested for canning or freezing. It is practical, however, to cull a small percentage of weevily peas from the dry-pea crop or to fumigate the harvested seed.

Green Peas

The grower of green peas should attempt to eradicate the weevil completely from his fields. For peas grown for canning and freezing a dust containing 0.75 percent of rotenone or 5 percent of either methoxychlor or DDT should be applied at the rate of not less than 20 pounds per acre. The peas should be dusted between the appearance

of the first blossoms and the first pods to kill the adult weevils before they have an opportunity to lay their eggs. This period ranges from 2 or 3 days in hot weather to more than a week in cool, cloudy weather.

One application cannot be relied upon to protect the peas from reinfestation. Sunlight reduces the effectiveness of rotenone to about 24 hours. If more weevils fly into the fields, it may be necessary to dust a second and even a third time, particularly when rotenone is used.

The longer the application is delayed after the peas begin to blossom, the more weevils are likely to have flown into the field and the more will be killed by the insecticide. A delay of even one or two days after small pods have appeared, however, may result in the peas becoming so badly infested that they are unfit for canning or freezing. In general, it is much better to start dusting a little early.

Rain or wind sometimes interferes with the correct timing of the dust applications. The use of ground dusting equipment may be impractical in muddy fields, and excessively windy weather may make dusting ineffective. When the wind velocity approaches 10 miles per hour, dusting with ground equipment should not be attempted even though it is provided with a well-constructed hood or trailer. Both wind and rain are frequently accompanied by cool weather, which reduces weevil activity. The weevils do not lay eggs at temperatures below 65° F. Dusting, particularly with rotenone, while the weevils are inactive is not very effective.

Dry Edible Peas

For the grower of dry peas the control requirements are less rigid, as small amounts of weevil-infested peas can be removed in the course of cleaning. Furthermore, the relatively low value of the dry-pea crop will not justify so great an expenditure as for the green pea crops.

In general, one application of 5-percent DDT dust at 15 to 20 pounds per acre should be used on this crop. It should be timed to prevent the pea weevil from laying any eggs. The temperature should be above 65° F., with indications that it will go higher, since weevils are inactive at lower temperatures. The grower should be prepared to dust his peas immediately after delays caused by unsatisfactory weather; otherwise enough eggs may be laid to cause a serious infestation.

Austrian Winter Field Peas

For Austrian winter field peas a single application of 5-percent DDT dust is recommended—as soon as possible after the weevils have moved into the fields from their hibernation quarters. Where the vine growth is exceedingly heavy, as in the Willamette Valley in Oregon, the rate of application should be 20 or 25 pounds per acre. The peas should be harvested as soon as they mature and fumigated immediately in order to kill the grubs before they have fed sufficiently to affect the viability of the seed.

Control of the pea weevil in Austrian winter field peas differs essentially from that in other pea varieties, because they are not used for food and the sole requirement for a commercial product is seed that will stand a satisfactory germination test (usually 90 percent or higher). The presence of infested peas in the final product is unimportant, provided the weevil larvae have been killed by fumigation before they become large enough to impair germination. On the other hand, the viability of almost all the early infested seed peas is destroyed before harvest, and in order to obtain a marketable product such seeds must be removed in the course of cleaning. Unless early infestations are controlled, losses in yield may be very high. In severe infestations ordinary methods of cleaning are inadequate to separate the sound from the weevil-infested seed.

DETERMINING WHERE TO DUST

Since the pea weevil populations are generally not distributed uniformly throughout a field, but are most often concentrated in a narrow zone around the edges, especially the edges close to favorable hibernation quarters, it is often unnecessary to apply the rotenone-dust mixture to an entire field, particularly if it is fairly large. The parts of the field that require dusting can be determined only on the basis of actual weevil-population surveys made by the grower or control operator. Such surveys are most quickly and accurately accomplished by the use of an insect-collecting net. Figure 6 shows the insect net

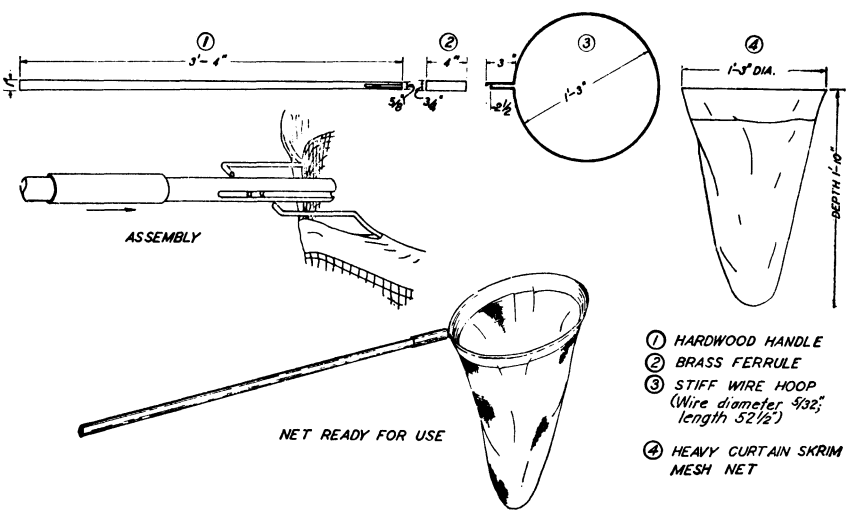


FIGURE 6.—Insect-collecting net used for the determination of pea weevil populations.

commonly used for this purpose and how it is made. In heavily infested areas, particularly where peas are grown for canning and

freezing, it is often necessary to dust the entire acreage of small fields, that is, those that do not exceed 8 to 10 acres.

The method of determining the weevil infestation may be outlined as follows:

Sweep the field soon after the first blossoms have appeared and before dusts have been applied. Go into the field in several places on each of the four sides or, if the field is irregular in shape, sweep at intervals around it. Each stroke across the upper part of the vines is considered a sweep. Hold the net at such an angle that weevils knocked off the vines will fall into it. Take a step or two between each sweep. Figure 7 shows the proper way to sweep. Make two or more 25-sweep collections at each place swept and count the weevils in each collection. Work toward the center of the field until no more weevils are found. In a field of seed peas sweep toward the center of the field until the weevil population drops below the number for which it is considered profitable to dust, as discussed in the following section of this bulletin. On a rough map of the field mark the locations where the weevils were collected. To keep track of these locations it is helpful to step off the distance from the edge and sweep at 100-foot intervals. For instance, if a number of weevils are found 200 feet from the edge of the field, walk another 100 feet and sweep again. If this method is followed, it is easy to mark the distance on the map.

Pay particular attention to the places most likely to be severely infested. Examine the edge nearest extensive timbered or brushy areas, ravines, and gullies running into the field; the vicinity of sheds or trees; and areas where the first peas blossomed, if the bloom is spotted. Check on the effect of the dusting operations in a similar manner 18 to 24 hours after dusting. If many weevils are found, it may be necessary to dust again within 3 or 4 days. It should be emphasized again that the green-pea field must be kept practically weevil-free, but in seed peas a light infestation is not so important. For this reason a more thorough check is needed on the green-pea field, both before and after dusting.

The question is frequently asked, How many adult pea weevils does it take to produce an infestation of 5, 10, or 15 percent in the harvested peas? An infestation resulting from a given number, as determined by sweeping with a collecting net, varies greatly in different fields. Weather has an important effect on both the yield of the peas and the activity of the weevils. The same number of weevils, as determined by sweeping, produce a greater infestation in the later fields than in the early ones. A population of 5 weevils in 50 sweeps often causes an infestation at the canning stage of about 1 to 2 percent in the early Alaska, Surprise, and Wisconsin Early Sweet peas, whereas the same population in the later varieties (Perfection and others), which bloom after June 15, results in an infestation of 10 to 25 percent at the canning stage. An infestation in the dry seeds resulting from 1 weevil in 25 sweeps averages from 3 to 8 percent in the harvested peas. In undusted midseason and late peas in eastern Washington, 1 weevil in 500 sweeps produces an infestation that generally ranges from 0.2 to 0.8 percent at the time of vining; 2 weevils in 500 sweeps produces an infestation that generally ranges from 0.6 to 1.1 percent. The higher percentages of infestation in late peas is due

partly to higher temperatures, which are more favorable to egg deposition, and partly to the ranker, leafier type of growth, which makes them more difficult to sweep, so that probably a smaller fraction of the weevils are picked up by the net.

FIGURE 7.—Sweeping with an insect-collecting net to determine pea weevil populations.

By applying this information a farmer or pea processor can determine whether dusting would be economical. For example, a producer of dry peas, knowing that the collection of 1 weevil per 25 sweeps would cause a loss of 3 to 8 percent of the harvested peas over the infested area, and also knowing the value of the crop and the cost of application, would be able to determine just how much of his crop could be dusted with profit.

SUPERVISION OF LARGE-SCALE OPERATIONS

Some processors and some canning-pea growers who operate on large acreages have found it profitable to employ trained entomologists to supervise weevil-control work. These men are responsible for the

proper timing of dust applications under the local conditions encountered and for determining the field areas to be treated. They must also see that dusting is repeated when and if necessary and that in general only clean peas, satisfactory for processing, are harvested. It is important that such men be well trained and fully familiar with the pea weevil problem. If this practice were more generally followed in important or concentrated pea-producing areas, greater profits would probably result.

AIRCRAFT DUSTING

The application of insecticides by aircraft (fig. 8) for control of the pea weevil is successful where the ground is not too rolling and there are few flight hazards in and about the field.

FIGURE 8.—Airplane applying dust for pea weevil control.

Treating pea fields from the air has certain advantages, particularly on large acreages or on those to be irrigated, or when the time available for application is short. Normal cropping practices are not disturbed, and the plants are not subject to damage by equipment. Aircraft cannot be used to apply dusts when the wind velocity exceeds 2 or 3 miles per hour. The drift of dust to adjacent fields also may cause difficulty.

When aircraft is used, flagmen should guide the pilots so that no infested parts of the field will be missed. Some operators provide flagmen; others rely on the farmer to provide this service. Field

checkers should give especial attention in the vicinity of flight hazards, as such areas might need additional treatment with ground equipment.

EQUIPMENT FOR GROUND DUSTING

A number of satisfactory dusters have been developed for use in pea weevil control. With the aid of a light canvas hood on a frame built out over the dust outlets, it is possible to make satisfactory application in winds having velocities up to 10 miles per hour. The dust mixture swirls in a heavy cloud within this hood before settling on the vines, so that a very even distribution is obtained (fig. 9). Most hoods are 3 or 4 feet high and project from 12 to 25 feet on each side of the machine.

FIGURE 9.—A typical dust cloud following the application of a rotenone dust mixture with a duster equipped with a hood.

The top of the hood is supported by a stout frame, which is jointed to the sides of the vehicle so that it can be folded when the duster is moved to or from the field. The bottom of the hood is weighted with some heavy material, such as rope, hose, or chains, to prevent whipping by the wind.

The boom is sometimes enclosed by a short apron, which hangs down vertically in front of the dust outlets and affords additional protection from the wind while the mixture is being applied.

No two dusting machines have been built entirely alike (fig. 10), and the hood, together with the boom, has been folded in various ways. Constructing the hood so that it can be easily and quickly folded speeds operations and enables better timing of applications. Some hoods can be folded and swung either to the front or to the rear of the machine (fig. 11, *A*). Others can be telescoped to reduce the length when the machine travels to or from the fields. On others the frame is jointed on each side of the machine so that it can be folded

over before being raised to a vertical position (fig. 11, *B*). If the duster is efficiently constructed, it should not take more than 4 or 5 minutes to fold the hood and make all preparations to move to the next field.

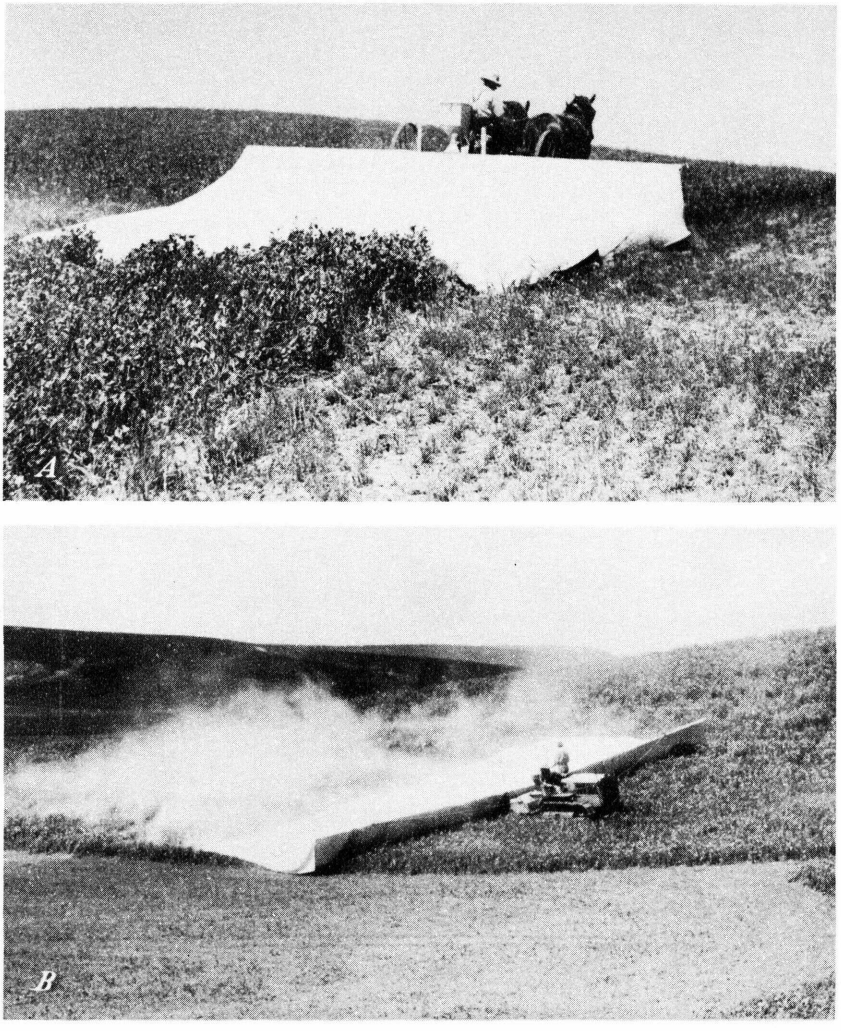


FIGURE 10.—*A*, Small horse-drawn machine duster covering a swath 20 feet wide; *B*, large tractor-drawn and powered duster covering a swath 60 feet wide.

There are two kinds of discharge outlets—nozzles and perforated booms. Both have proved satisfactory. On nozzle-type dusters the number and arrangement of the discharge nozzles can be varied. In some places as few as three nozzles have proved satisfactory when box-type hoods were employed. Usually, however, five or more

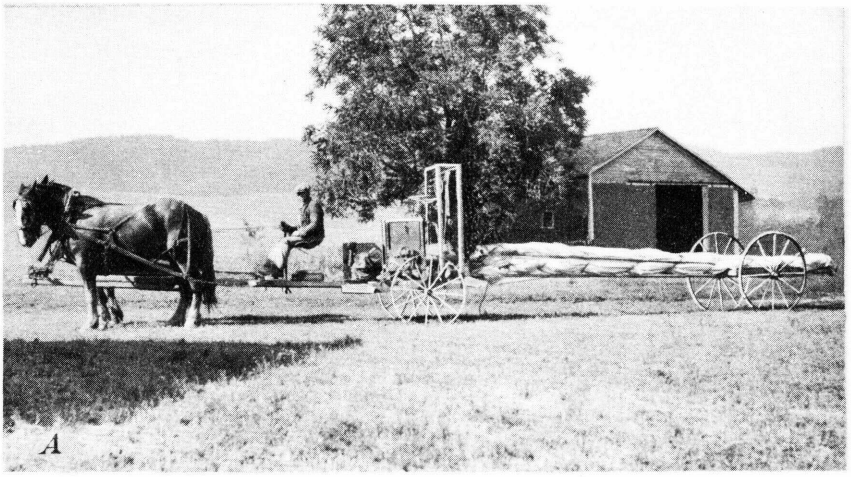


FIGURE 11.—*A*, Duster constructed so that the hood and boom assembly can be folded and swung to the rear of the dusting unit; *B*, duster built so that the hoods can be folded and raised to a vertical position.

nozzles are used, arranged, after experimentation, to ensure an even covering of the dust mixture. As an example of the perforated boom, a duster was fitted with two 20-foot booms, one on each side of the machine. These booms were prepared by welding an 8-foot section of 3-inch boiler pipe to a 6-foot section of 2¾-inch pipe and then welding to these a 6-foot section of 2¼-inch pipe (fig. 12, *B*). Holes, ⅜ inch in diameter and 4 inches apart, were drilled along the bottom. A feed made of flexible tubing connected the larger end of the pipe with the

dust blower. The end of the boom was fitted with a removable pipe cap, so that the pipe might be cleaned, should it become clogged.

Most of the dusters cover a swath from 30 to 50 feet wide. They

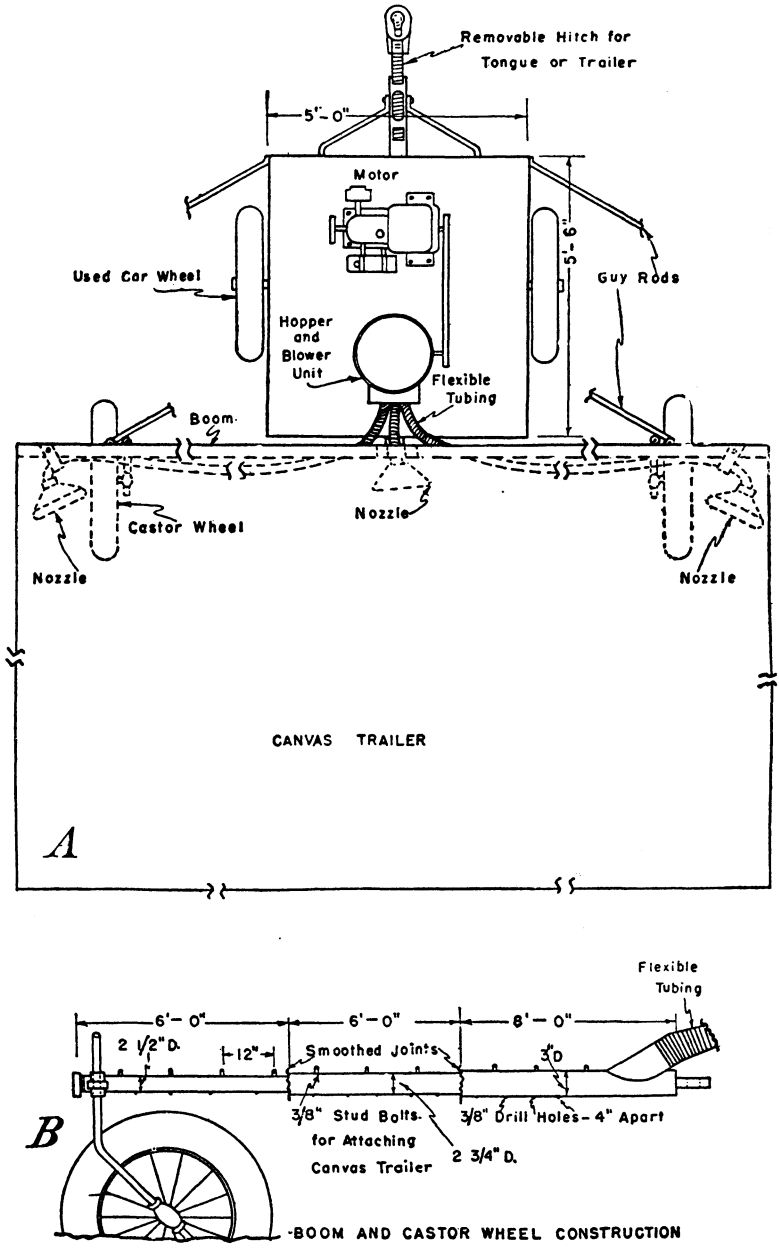


FIGURE 12.—*A*, Diagram of duster, showing nozzle-type boom; *B*, detailed section of perforated-type boom.

FIGURE 13.—*A*, Caster wheel at end of framework of the duster hood. Such wheels keep the hood at a constant distance from the ground and eliminate the use of a windlass. *B*, Duster with hood of the trailer type. This type of hood affords protection from wind during the dusting operation. The unit is mounted directly on the tractor, and the booms are supported by caster wheels.

have been mounted on trucks or tractors or on truck- or horse-drawn trailers.

Where fields are several miles apart or where they are so steep that

the duster must be pulled by a crawler-type tractor, time is saved by loading the tractor and the dust mixture onto a truck and hauling the duster behind the truck to the next field.

Most dusters are operated by two men, one driving the machine and the other regulating the distance of the hood from the ground by means of a simple windlass arrangement. One windlass for each side of the hood enables the operator to obtain the best adjustment on sloping land. The windlass should be large enough in diameter to enable the hood to be raised without a great deal of turning of the windlass wheel.

On some machines, however, the windlass wheel has been eliminated by the use of a caster wheel placed near the end of the supporting boom (figs. 12 and 13). This wheel keeps the trailer hood at a uniform height above the peas, no matter what kind of ground surface is being dusted. The use of caster wheels also eliminates the construction of a costly and heavy supporting framework for the duster boom. Little damage is done to the vines by these wheels because they support little weight.

Accurate mileage can be determined with a speedometer connected with a bicycle or automobile wheel riding on the duster wheel; or, if the duster is mounted directly on a tractor, riding on the treads of the tractor. Such a record makes it possible to determine how many pounds of dust mixture are being applied per acre, so that the grower may know whether he is wasting dust or not applying enough.

Dusting machines of the type used in pea weevil control can be purchased from local implement dealers. Most shops that specialize in the repair and maintenance of farm machinery can mount and equip machines in the manner described in this bulletin. Made-to-order canvas hoods can be supplied by dealers in dusting machines.

Damage Caused by the Dusting Equipment

The damage to the peas that results from running the dusting equipment over the vines varies with the slope of the ground, the weight and width of the duster, the width of the duster tracks, and other factors. For instance, a 30-foot duster mounted on a truck or a duster pulled by a caterpillar tractor with 8-inch cleats frequently causes enough damage to reduce the yield between 3 and 4 percent in the part of the field that is dusted. Horse-drawn dusters usually do less damage per trip than dusters pulled by machine equipment, but since they usually dust a narrow swath and have to make more trips across the field, the damage done in the end is approximately the same. Duster damage can be materially reduced either by increasing the width of the duster, which means decreasing the number of trips across the area to be dusted, or by decreasing the width of the tracks made by the dusting equipment. Light dusting equipment, which reduces damage, is of especial importance in small fields.

CONTROL WHERE THE PEA APHID ALSO THREATENS DAMAGE

Sometimes the pea aphid needs to be controlled at the time insecticides should be applied against the pea weevil. Both insects may be controlled with 5-percent DDT dust provided it is applied with ground

equipment. Parathion dusts and sprays are more effective against the pea aphid and fully as effective against the weevil. A ready-made 1-percent parathion dust is suitable for use with ground dusters. For application from aircraft, 1½ pints of 25-percent parathion emulsion concentrate or 1½ pounds of 25-percent parathion wettable powder should be used per acre in 4 or 5 gallons of water spray. The parathion emulsion may cause slight spotting or bronzing of the leaves and pods, but this injury does not appear to affect the yield.

CAUTION

Parathion is an extremely dangerous poison. It should be used only by trained operators who will assume full responsibility and enforce proper precautions as prescribed by the manufacturers.

Persons using parathion should avoid getting any of the material on the skin, especially if it is concentrated. The shirt should be kept buttoned at the neck and the sleeves rolled down and buttoned at the wrist. The operator should wear rubber-covered gloves, a protective head covering, and a cover-all, smock, or coat of rubberized cloth that can be washed after each wearing. After each application the hands and face should be thoroughly washed with soap and water. Any insecticide that is spilled on the skin should be washed off immediately.

A person mixing or applying the insecticide should wear a tight-fitting respirator equipped with a canister specified for use in handling of organic vapors, acid gases, and dusts. The canister should be replaced with a new one after use. Pilots should wear goggles that give a tight seal with the respirator around the nosepiece. Other persons exposed even to small amounts of the insecticide should faithfully use respirators.

A person developing headache, nausea, impaired vision, or tightness of the chest when using parathion should go or be removed to fresh air immediately. He should be given an emetic such as mustard or warm soapy water and a doctor called. Atropine sulfate is an antidote for parathion. It may be obtained by prescription in $\frac{1}{100}$-grain tablets and kept on hand for use in an emergency. For severe poisoning two tablets should be taken at once and a doctor called immediately. Atropine is not a preventive, and its use as such is extremely dangerous.

After parathion has been used for pea weevil control, the fields should be checked frequently. It may not be as effective as DDT in killing weevils that enter the fields after application. When parathion is applied when the plants are in early bloom, there should be no residue at harvesttime. Parathion should not be applied within 10 days of harvest.

USE OF BORDER TRAP STRIPS

In some areas a strip of early blooming peas is sown around the margin of a large field to serve as a trap crop. This strip is usually one drill-strip wide and is so planted that it blooms a week or 10 days

ahead of the main field. It attracts large numbers of pea weevils, causing them to concentrate where they may be destroyed. Weevils concentrated in the borders must be eliminated by the application of dusts at the same rate and with the same equipment recommended for regular field control. The dust should be applied to the border trap strip before the buds in the main field show any white coloration.

Because pea weevils sometimes fly into the blossoming field after the weevils in the border trap strip have been destroyed, the grower often has to dust this strip a second time and also has to dust a portion of the main field. Nevertheless, the quantity of dust used in control and the size of the area treated are usually less than if border trap strips had not been used. In seed-pea areas, where the grower is merely attempting to reduce this population as much as possible with a minimum of dusting, the use of a border trap strip enables him to kill a great many weevils with a relatively small quantity of the dust. In general, the use of border trap strips is not recommended except for fields of 75 to 100 acres or more.

If the border trap strip is to be helpful rather than harmful, certain precautions should be observed. It is important that the pea weevils in these strips be destroyed by dusting before the main field blooms; otherwise some weevils will fly over into the main field. The peas in these borders are often heavily infested and, if the crop is grown for canning, should be plowed under or otherwise destroyed as soon as possible after the main field blooms. Unless the plowing is carefully done, some pea vines are likely to catch onto the plowshares and be left in small bunches scattered along the border. If these peas are infested, the chances are that the pea weevils will develop within them and become a menace to the next year's crop. Deep plowing, with the use of jointers, usually buries the peas effectively. Going over the border with a packer helps to prevent any pea weevils that may develop in the buried peas from forcing their way to the surface of the soil. In some cases, where the border dusting has been effectively done, the peas in the border strip may be harvested. *If peas are being grown on contract, border trap strips should not be planted without the consent of the firm granting the contract.*

SANITATION AND RELATED PRACTICES

To reduce pea weevil populations from year to year, certain cultural and sanitation practices should be adopted, as follows:

1. Plant weevil-free seed. Large numbers of pea weevils are able to escape from weevily seed and infest the growing crop.

2. Use good seed stock. Any practice that will eliminate rogue pea plants will aid in keeping down the pea weevil infestation and the cost of control. Good seed planted in a good seedbed is an important factor. A few early blossoms in a peafield may attract weevils out into the field several days before the field as a whole begins to bloom. To destroy these weevils before they lay eggs, it may be necessary to dust entire fields when few blooms are present. Because this application must be made before the true variety blooms and usually before the weevils are out of hibernation, a second dusting may be required after the field comes well into bloom and more weevils have

flown in, whereas only one dusting would have been needed had all the peas bloomed at the same time.

3. Do not grow seed peas in green-pea districts. The pea weevil population in areas devoted primarily to growing green peas for canning, freezing, or the green-pod market can be greatly reduced if no peas are allowed to ripen in such districts. It is possible, however, with the application of recommended control measures, to grow both seed and green peas in such areas. In eastern Washington the harvest loss is greater and the weevils are further developed at harvesttime in the seed-pea fields than in the green-pea fields; consequently a much larger percentage of weevils survive in the shattered seed peas. On fields harvested for seed in Columbia and Walla Walla Counties, Wash., the shatter of pea seed of the same varieties was found to be 6 to 7 times as great as on fields harvested for the cannery. In one study more than 20 times as many pea weevils developed from shattered seed peas as from cannery peas collected from areas of equal size in adjacent fields.

The following is an example of the effect on the abundance of pea weevils of an undusted field left for seed in a canning-pea area. One farmer raised 9 acres of peas for hay, so planted that they blossomed just ahead of the canning peas in the area and became host to most of the weevils in the vicinity. The peas were cut for hay, raked, and stored in the barn. On the basis of collections made at random on the plant residues left on the surface of the harvested field, it was estimated that approximately one-quarter of a million pea weevils developed and emerged on these residues. This total probably exceeded the total number that reached the mature stage in approximately 2,000 acres of canning peas surrounding this field.

4. Harvest seed peas as soon as they ripen. This is important from the standpoints of both yield and weevil damage. Sometimes peas are cut while still green and are left in windrows to dry before being harvested. This practice enables the farmer to thresh the peas earlier, but does not materially reduce field shatter.

5. Fumigate Austrian Winter field peas as soon as they are harvested. Harvest them as soon as they ripen, and fumigate them immediately; otherwise the feeding of the weevil larvae within the peas will steadily decrease their weight and lower the percentage that will germinate. Effective fumigants include hydrocyanic acid, methyl bromide, chloropicrin, or a 3:1 mixture of ethylene dichloride and carbon tetrachloride. Instructions for their use are given in AMS–64, Protecting Stored Seed from Insect Attack, issued by the Agricultural Marketing Service.

6. Store dry edible peas until the weevil larvae mature, and then fumigate them. Consult the agricultural college or department of agriculture in your State or the Agricultural Marketing Service as to what fumigant to use. Be sure that the fumigant you buy has a label giving instructions for treating dry edible peas, and follow these instructions. The peas should be stored in tight bags under conditions favorable for rapid weevil development. When the adults have emerged, the peas should be fumigated or otherwise treated to kill the living weevils present, and thus prevent their escape and the subsequent infestation of the next year's crop.

7. Do not allow weevils to complete development in peas left in the field. Deep plowing, using jointers, immediately after harvest destroys most of the weevils in peas left on the field. Unless they are properly handled, weevil-infested peas intended for canning, but left for seed, breed more weevils for succeeding crops. Such peas should be harvested as soon as they are ripe, to prevent the escape of weevils. Some growers and canners prefer to plow under such peas, or to cut them green and use them as hay or ensilage. If the peas are cut for hay, it should be used before spring to prevent weevils from surviving. Practically all the weevils in the peas used for ensilage are destroyed in the curing process.

Peas grown as a green-manure crop should be plowed under shortly after blossoming and before any pods have started to fill.

After canning peas are harvested the pasturing of livestock is an effective method of destroying weevil-infested peas left in the field, but this practice is not very effective after dry peas have been harvested.

Burning over harvested fields kills the pea weevils in shattered peas left on the field. *This practice is not recommended, however, because of the injurious effects on the fertility and texture of the soil.*

Whenever fields are some distance from favorable overwintering places, such as timber or brush, it may be advantageous to clean up abandoned orchards, old fences, and farm buildings or any other places in which the weevils pass the winter near the peafield.

CONTROL IN HOME GARDENS

Pea weevils in farm and home gardens must be eliminated if the gardener is to produce sound peas. The presence of the pest can be determined by examining the pea flowers and terminal buds. If any weevils are found in a 5-minute examination, the peas should be dusted. The dust should be applied with a hand duster, and the entire plant should be covered completely with a thin layer of the insecticide. One-fourth of a pound to each 150 linear feet of row should be sufficient. Control can also be accomplished by dusting with the same mixture at intervals of 4 to 5 days from the time the peas start blossoming until the green-pea harvest is over.

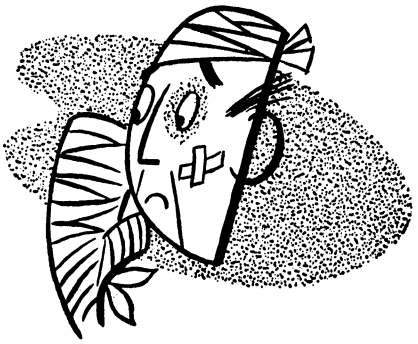
WHERE INSECTICIDES MAY BE PURCHASED

Information regarding the purchase of the insecticide materials mentioned in this bulletin may be obtained through local dealers in agricultural supplies, seedsmen, general stores, and department stores or through county agricultural agents, State agricultural colleges or experiment stations.

U. S. GOVERNMENT PRINTING OFFICE: 1956 O—372318

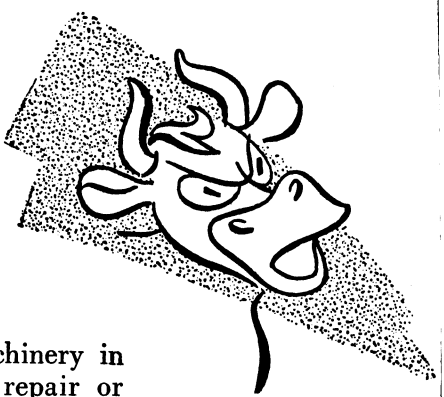
For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 15 cents

Farm Accidents Each Year . . .



- Kill about 15,000 people.
- Injure or cripple about 1¼ million more.
- Cause loss of 17 million man-days of farm labor, or the services of 46,000 men working every day for a year.

Help Prevent Most of These Accidents!



- Keep tractors and other farm machinery in good repair. Equipment in bad repair or carelessly handled ranks first in killing or injuring farm people.
- Handle bulls and other farm animals carefully. They rank second in causing farm accidents and deaths.
- Use sharp-edged tools with caution—sickles, saws, corn knives, chisels, screwdrivers, axes.
- Take proper care in using, handling, and storing insecticides and other poisonous chemicals.
- Install, use, and repair electrical appliances and equipment properly.

You can lessen the seriousness of many accidents by immediate and proper care. Keep a first aid kit handy and know how to use it. **Cail a doctor.**